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ABSTRACT

An exploratory study probed the extent to which children rely on category membership to guide their inferences. A total of 60 children, 4 years of age, were shown 20 sets of pictures of various animals, plants, and minerals. Each set consisted of representations of three objects having two salient features: perceptual similarity/dissimilarity and category membership/nonmembership. Given information about a category member (for example, feeding behavior of flamingos) plus information about a category nonmember (feeding behavior of bats), subjects were asked to draw an inference about a category member (for example, a blackbird) that was perceptually similar to the category nonmember (the bat). At least two possible responses existed: inferences based on perceptual similarity (blackbird and bat) or on category membership (flamingo and blackbird). Control conditions were established to ascertain that the information given was unfamiliar to subjects and to demonstrate children's ability to perform when category information was not in conflict with perceptual information. Replicating the experimental condition, a second study asked children to justify their choices. Results showed that the category label had a powerful effect: 68 percent of the time preschool children preferred to draw inferences on the basis of category membership. Children's justifications provided converging evidence that they firmly believed in the importance of category name. No clear-cut item effects due to domain-specific knowledge were found. (RH)

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Natural Kind Terms and Children's Ability to Draw Inferences

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Abstract

For adults, certain "natural kind" categories allow us to infer that properties true of one category member are probably true of another. For example, most *tigers* have many features in common (e.g., striped fur, four legs, certain bone structure). The present research examined children's understanding that members of a natural kind category share certain properties. We gave children the opportunity to draw inferences on the basis of an object's outward appearance, or on its category membership. Four-year-old children saw pictures of various animals, plants, and minerals. For each picture set, one pair was obviously more similar (e.g., a blackbird and a bat), but a different pair included members of the same category (e.g., two birds: a blackbird and a flamingo). Children were taught new information about two of the pictures, then asked a question about the third picture (e.g., "Does this bird [blackbird] give its baby milk or mashed-up food?"). If children rely on outward appearance to infer new information, they should say that the blackbird (like the bat) gives its baby milk. However, if children recognize that members of a natural kind are alike in underlying ways, they should say that the blackbird (like the flamingo) gives its baby mashed-up food. Our results show that the category label had a surprisingly powerful effect. Sixty-eight percent of the time, children believed that members of the same category behave alike, despite perceptual dissimilarity. These results suggest that preschoolers appreciate that natural kind categories promote inferences. For young children, labelling can have an effect that overrides the object's appearance.

Natural Kind Terms and Children's Ability to Draw Inferences

Today I would like to tell you about some research I have conducted in collaboration with Ellen Markman. We were interested in how natural language categories (such as giraffe or water) help young children induce new information.

Natural language categories are an efficient way of organizing our world knowledge. For example, we know that the world includes a number of creatures that all have four legs, long necks, spots, horns, and a list of other details. So it is economical to group these animals into a single category. By calling them all "giraffes," the facts we have learned about these objects are linked to a single label. From then on, we can let the label guide our behavior toward giraffes as a class.

But categories capture more than the obvious features that people already know. They also capture a great deal of similarity between objects that you would not know by casual inspection. Consider the category of giraffes again. In addition to the obvious features in common to most (such as spotted fur or long necks), giraffes have a particular diet, life expectancy, gestation period, DNA structure, and so forth.

We suspect that anyone who wants to devise a "good" system of classification hopes to be able to draw inferences from it. It is not enough to divide up objects simply to organize what is already known. In the present set of studies, we explored whether children appreciate that certain categories have this rich structure. That is, we studied whether children believe that members of a category share certain non-obvious features that they do not yet know about.

Today I will talk about two studies we have completed with children. In these studies, we have asked whether children believe that members of a category (e.g., all birds) share a rich set of features. So, as shown in Figure 1, we asked children to draw an inference about one object (such as a bird), on the basis of learning something new about another object of the same category (another bird). Moreover, this category information was placed in conflict with other information, about an object more perceptually like the new object (e.g., a bat).

The major purpose of this study was exploratory, simply to see to what extent children rely on category membership to guide their inferences. There are at least two possibilities. On the one hand, children may draw inferences based on perceptual similarity. On a wide range of cognitive tasks: memory, quantitative reasoning, perspective-taking, children have a strong perceptual bias. They are captured by superficial appearance and seem unable to shift their attention away from perceptual features. Children may apply this way of thinking to common objects that they see every day. For example, if children see a bat, they may believe it is essentially a black bird. If children do rely on appearances rather than category labels when inferring new properties of objects, this would mean that, unlike adults, they do not realize that categories per se promote inferences. A second possibility is that even for preschoolers, category membership may promote inferences. Young children may have a primitive understanding of how categories are organized, even before they can back up their beliefs with solid scientific evidence. This would show a surprisingly early appreciation for the rich structure of categories.

We wanted items that would in fact promote inferences from one category member to another. Therefore, we had two criteria for choosing items. First, we used categories that some philosophers call natural kinds (Kripke, 1972; Putnam, 1973; Schwartz, 1977). These are classes of objects found in nature: animals, plants, or minerals. For example, two categories we

included were gold and squirrel. Because children may draw the appropriate inferences in some categories before others, we included objects from two very different domains: biological (e.g., starfish) and non-biological (e.g., diamond). Second, attributes were of intermediate generality: true of an entire natural kind (for example, all birds, but not of all animals), or true of gold, but not of all minerals. We included attributes that children would understand, but not ones that children already knew. All attributes were pretested, to make sure that 4-year-olds did not already know the information we would be teaching.

Each child saw 20 sets of pictures of various animals, plants, and minerals. I will describe one such set in detail, to illustrate the sort of problem we gave to children, but the other questions were analogous to this one. For example, on one set children saw two different kinds of birds and a bat. Figure 1 illustrates this. The experimenter first labelled the pictures. Then children would hear, "This bird [pointing to the flamingo] gives its baby mashed-up food; this bat gives its baby milk. [Pointing to the blackbird]: Does this bird give its baby mashed-up food, like this bird, or milk, like this bat?" One pair of pictures looked obviously very much alike--here, the blackbird and the bat. The other pair consisted of two members of the same category--here, two birds: a blackbird and a flamingo.

We were interested in whether children make use of the additional information. If relying on outward appearance, children should say that the blackbird (like the bat) gives its baby milk. But if children recognize that members of a natural kind are alike in underlying ways, they should say that the blackbird (like the other bird) gives its baby mashed-up food.

We tested 60 children in this study; all were 4 years old. These were the youngest children that could be tested with this procedure, since in pilot- testing 3-year-olds could not remember all of the information. Our results show that the category label had a surprisingly

powerful effect. As shown in the first column of Table 1, 68 percent of the time, these preschool children preferred to draw inferences on the basis of category membership, even when pitted against striking perceptual similarity (above chance of 50 percent, $t(18) = 3.68$, $p < .005$). For example, after being told that a bird gives its baby mashed-up food and that a bat gives its baby milk, they infer that another bird gives its baby mashed-up food, like the first bird.

There were also two control conditions. On one, we simply asked the questions without giving the additional attribute information. For example, we showed children the blackbird only and asked, "Does this bird give its baby mashed-up food, or does it give its baby milk?" If children are guessing in this condition, it would mean the facts we were teaching were unfamiliar, which we wanted. As you can see in Table 1, children were performing at chance in this condition. When simply given the test question, with no extra information to guide their answer, children were correct only 53 percent of the time (not different from chance, $t(19) = 1.24$, n.s.).

The other control served to demonstrate that children performed quite well when category information was not in conflict with perceptual information. For example, we showed children two black bats and a flamingo, and asksed, "Does this bat give its baby mashed-up food, like this bird, or milk like this bat?" And in fact, when given information about a perceptually similar object from the same category, children were able to use the extra information 88 percent of the time to arrive at the right answer (above chance, $t(19) = 10.5$, $p < .001$).

Both control conditions differ significantly from the teaching condition (1-way anova, $F(2, 56) = 23.3$, $p < .001$). These results suggest that young children, before having any formal schooling, realize that natural kind categories promote a rich set of inductive inferences.

They have come to expect new knowledge to be organized in accord with the categories named by their language.

In a second study, we replicated the experimental condition and asked children to justify their choices. Our data are consistent with the findings from Study 1. Again, overall performance was impressive: 73 percent of their choices were categorical (better than chance, $t(17) = 5.08$, $p < .001$). These children clearly believe that the category label is a better clue to an object's behavior and internal structure than is outward appearance.

Children's justifications provided converging evidence that they firmly believed in the importance of the category name. Children frequently made comments such as, "because it's a bird!" (age 4 years, 9 months) or "because it's a diamond--there are two diamonds" (age 4 years, 3 months). Some subjects even drew a more general conclusion: "'cause every dinosaur has cold blood--even when it's frozen" (age 4 years, 2 months). And in pilot-testing, one articulate 7-year-old explained, "because all snakes should be a little bit the same and a little bit different--inside they should be the same."

To sum up, in this work we have examined how natural kind categories promote inferences above and beyond perceptual appearance. We hope this work points out that categories serve not only to organize information that is already known. They also allow us to infer more about the world than we knew before. Our work also suggests that a lot of knowledge gets passed down implicitly through the system of categories we teach our children. What is surprising is that this goes on even before children enter school.

We had originally hypothesized that children might start out with a perceptual bias, only gradually coming to realize that category members share non-obvious features. It was

possible that children would not appreciate the rich structure of categories until they learned enough scientific facts. However, our data suggest that this isn't going on. Children as young as we could test assume that the category governs inferences of new information. Furthermore, there were no clear-cut item effects due to domain-specific knowledge. That is, it did not matter if inferences were about biological categories such as squirrel, or nonbiological categories, such as metal. Children are drawing inferences at such an early age, it leads us to think that they may *start out* with a bias to assume that all categories named by language promote inferences. They would then have to learn, with development, when it is not appropriate to draw inferences.

Accordingly, we are currently investigating whether children overextend their view of natural kind categories when thinking about nonnatural kinds (e.g., chairs, cups). Intuitively, it seems that the inferences one can draw about artifacts such as chairs are much more limited than those one can draw about natural kinds such as dogs. Although dogs have so many features in common that a science could be devoted to their study, a science devoted to the study of chairs seems ridiculous. However, very young children may infer that what is true of one chair is true of most others.

In sum, although the distinction between natural and nonnatural kinds is not typically made in the psychological study of human categories (e.g., Rosch et al., 1976), our studies suggest that perhaps it should be. In this initial investigation, we have found that natural kind categories allow even young children to go beyond the original basis for grouping objects into a category, and promote a rich set of inferences.

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Figure 1. Sample question:

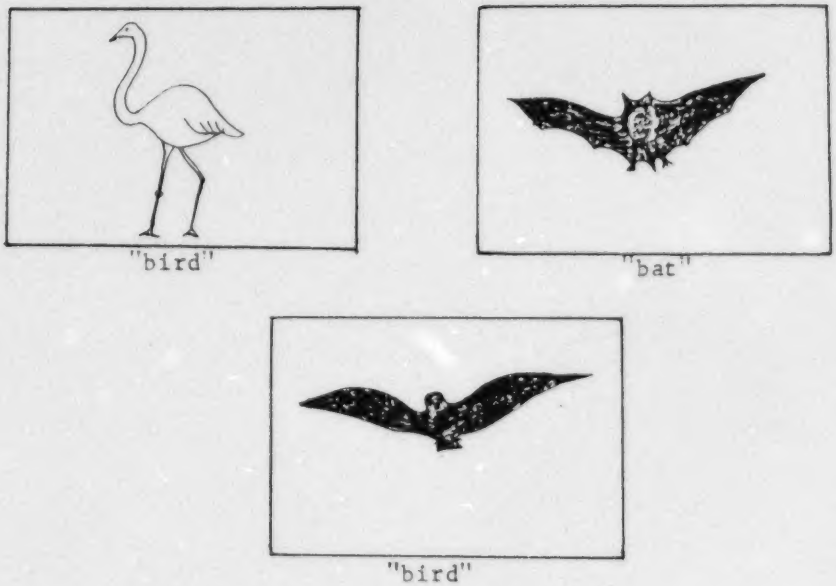

Table 1. Mean Percent Correct:

STUDY 1			STUDY 2
Teaching Condition	Test Question (Control)	No Conflict (Control)	Teaching Condition
68%	53%	88%	73%